consumption of the Oxygen-18 water as compared to a conventional water target. Let's compare the consumption of Oxygen-18 water in the present target with a conventional water target. Since the range of an 11 MeV proton in water is about 1.2 mm the length of the water column as seen by the beam in a conventional water target should not be much larger than 1.2 mm. However, this length which is also called the target depth is around 1.2 cm for a moderate beam power and around 1.5 cm for 40 mA beam. That is, the target depth is about ten times the range of proton in water for a moderate beam power and is larger than ten times for a high power beam. The reason for this is because of formation of bubbles or voids due to boiling of the water, which was explained in the BACHGROUND section of this application. In the present invention, however, the material sample is already in the form of steam. Compared to the water target, the material sample of the present target is already made of a bubble, a giant bubble that cannot change phase as the beam current increases. Subsequently, the length of the steam column as seen be the beam should be such that the beam encounters the same amount of water molecules as it would in a 1.2 mm long water. The obvious conclusion of comparing this 1.2 mm with 1.2 cm is that a water target of 1.2 cm long uses ten times more water that the present target.

The other objects of the present invention is to replace the four dedicated targets of PET with one single target. It was shown in this section that the steam target of the present invention which replaces the conventional water targets is also quite suitable to operate as a gas target.

Further objects of the present invention is to reduce the density depression that occurs in a gas or a steam target. This was achieved by creating a magnetic field in the target with field lines along the beam path.

CLAIMS

Claim 1. A target system for confining a material sample to be irradiated with a beam of charged particles for producing a radioisotope, the system comprising:

a body having a substantially enclosed chamber for confining a material sample to be irradiated with a beam of charged particles;

means mounted within the body for heating, when desired, the material sample to an elevated temperature;

means associated with the body for preventing the body from exceeding a preselected temperature.

Claim 2. The target system as defined in Claim 1 wherein the body includes an entrance end through which charged particles are permitted to enter the chamber, and the chamber has a cross section whose size increases as a path is traced along the chamber from the entrance end.

Claim 3. The target system as defined in Claim 2 wherein the chamber interior is conical-shaped with the smaller end of the chamber interior corresponding with the entrance end of the body.

Claim 4. The target system as defined in Claim 1 wherein the body defines at least one opening having walls which are spaced from the walls of the chamber, and the heating means includes an electric heating element positioned within the at least one opening for generating heat with which the temperature of the material sample confined within the chamber can be raised.

Claim 5. The target system as defined in Claim 4 wherein the associated means includes means for conducting heat from the body when the body reaches a preselected temperature.

Claim 6. The target system as defined in Claim 5 wherein the body includes at least one fluid-conducting passageway, and the means for conducting heat from the body includes means for directing a cooling fluid through the at least one fluid-conducting passageway for purposes of cooling the body, and the associated means includes means for monitoring the temperature of the body.

Claim 7. The target system as defined in Claim 6 wherein the temperature monitoring means is connected to the heat conducting means so that when the temperature of the body reaches the preselected temperature, the operation of the heat conducting means is initiated.

Claim 8. The target system as defined in Claim 1 wherein the body includes an entrance end through which charged particles are permitted to enter the chamber, and the system includes

a thin foil positioned across the entrance end through which the charged particles must pass before they enter the chamber, and

at least one thin wire positioned across so as to span a side surface of the foil for providing structural support to the foil during operation of the system to enable the foil to withstand an appreciable pressure differential which can be developed on opposite side surfaces of the foil during use of the system.

Claim 9. A target system for confining a material sample to be irradiated with a beam of charged particles for producing a radioisotope, the system comprising:

a body having a substantially enclosed chamber for confining a material sample to be irradiated with a beam of charged particles and wherein the enclosed chamber has an entrance end through which charged particles are permitted to enter the chamber and is elongated in shape as a path is traced therealong from the entrance end and has a longitudinal axis; and

means for generating a magnetic field parallel to the longitudinal axis of the chamber.

Claim 10. The target system as defined in Claim 9 wherein the means for generating a magnetic field includes at least one electrically-conducting coil encircling the elongated chamber.

Claim 11. The target system as defined in Claim 9 wherein the chamber has an interior which is conical-shaped with the smaller end of the chamber interior corresponding with the entrance end of the body.

Claim 12. The target system as defined in Claim 9 further comprising:

a thin foil positioned across the entrance end through which the charged particles must pass before they enter the chamber, and

at least one thin wire positioned across so as to span a surface of the foil for providing structural support to the foil during operation of the system to enable the foil to withstand an appreciable pressure differential which can be developed on the opposite side surfaces of the foil during use of the system.

Claim 13. The target system for confining a material sample to be irradiated with a beam of charged particles for producing a radioisotope, the system comprising:

a first body having a substantially enclosed chamber for confining a material sample to be irradiated with a beam of charged particles and wherein the enclosed chamber includes an entrance end through which charged particles are permitted to enter the chamber; and

means mounted within the first body for heating, when desired, the material sample to an elevated temperature;

means associated with the first body for preventing the body from exceeding a preselected temperature wherein the associated means includes a second body attachable to the first body adjacent the entrance end of the chamber and including at least one fluid-conducting passageway, and the associated means further includes means for directing a cooling fluid through the at least one fluid-conducting passageway for purposes of cooling the first body.

Claim 14. The target system as defined in Claim 13 further including means for monitoring the temperature of the first body, and the temperature monitoring means is connected to the associated means so that when the temperature of the first body reaches the preselected temperature, the operation of the associated means is initiated.

Claim 15. The target system as defined in Claim 14 further comprising:

a thin foil positioned across the entrance end through which the charged particles must pass before they enter the chamber, and

at least one thin wire positioned across so as to span a side surface of the foil for providing structural support to the foil during operation of the system to enable the foil to withstand an appreciable pressure differential which can be developed on the opposite side surfaces of the foil during use of the system.